

AVIATION AND AERONAUTICAL ENGINEERING



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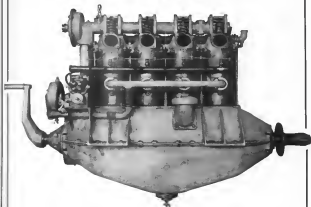
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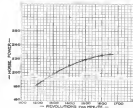
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Duration of test (minutes)	60
Average R. P. M.	1400.25
Average load on scales (lbs.)	647.54
Average horsepower	208.36
Maximum observed horsepower	246.50
Minimum observed horsepower	205.10
Total Gas consumption (lbs.)	512.30
Total Gas consumption (U. S. gals.)	16.00
Gas consumption per hour (lbs.)	111.30
Gas consumption per hour (U. S. gals.)	18.10
Gas consumption (lbs. per H. P. hour)	5.28
Total Oil consumption (lbs.)	5.50
Total Oil consumption (U. S. gals.)	8.64
Oil consumption (U. S. gals. per hour)	8.64
Oil pressure—start of test (lbs.)	75.00
Oil pressure—end of test (lbs.)	73.00
Oil pressure—maximum test (lbs.)	74.00
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DECEMBER 15, 1916

AVIATION AND AERONAUTICAL ENGINEERING INDEX TO CONTENTS

VOL. 1. NO. 10

	PAGE		PAGE
Aircraft in Pictures	316	The British Aeronautical Situation	325
Editorials	317	A Two-Propeller Tractor Model	326
Possible Improvements in Carrying Capacity of		Alfons Order 6,273 Hispano-Suiza Engines	327
Rigid Air Ships	318	Course in Aerodynamics and Airplane Design	328
Contracts Let by Army for \$2,067,800 Worth of		Aeronautical Patents	330
Seaplanes	320	News of the Fortnight	330
A Time Controlled Aerial Torpedo	322	\$100,000 Asked for Aerial Postal Experimentation	331
Latest Holston Dargac Reports on Night Flying	323	Orrin Wright's New Stachurski Almost Perfected	332
The Verville Pusher Type Seaplane	324	Ruth Law Flew at Liberty Himmelman	333
		Pan-American Aeronautic Exposition	334

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Possible Improvements in Carrying Capacity and Speed of Rigid Airships

By C. Dornier, Count von Zeppelin's Engineer
Author of "F. P. Rigid"

FUNDAMENTAL EQUATIONS OF THE AIRSHIP

Let L stand the available lift of the airship in cubic meters, Δ the difference in specific weights between air and air per cubic meter, then the following expression is obtained for the buoyancy of the ship, B :

$$B = L \times \Delta \text{ in kilograms}$$

The net weight W (empty weight) of the ship comprises the following weights: Weight of the frame, outer hull, steering apparatus, gas cells, ballast, propellers, struts, etc. The weight M of the machinery, including accessories for the propulsion of the ship comprises the weight of the motors and accessories, the tanks and pipes, the shafting and air propellers. If W_0 is the weight of the machinery, installation per horsepower in kilograms, then we obtain the following expression for the weight of the installation necessary to propel N horsepower:

$$W_0 = W_0 \times N \text{ in kilograms} \quad (1)$$

The amount of fuel oil necessary to drive the motor, per horse power hour (H), may be taken as constant, and we obtain the following expression for the weight of fuel necessary to fly at a height of h km:

$$M = h \times N \times T \text{ in kilograms} \quad (2)$$

If we subtract from the lifting force the net weight of the ship, the weight of the machinery, installation and the weight of the necessary fuel for the required time of flight, the remainder will equal the available carrying capacity, which may be utilized for passengers, crew, mail, etc. The relation for the available carrying capacity:

$$C = B - W_0 - M \quad (3)$$

is then obtained. If the resistance of the ship is s meters per second as equal to 10 kilograms, then the relation giving the necessary power for the development of such speed, P :

$$P = C \times s \quad (4)$$

where the overall efficiency of the machinery installation is η . The resistance offered by a ship in maintaining a speed of s meters per second is given by the equation:

$$R = C \times s^2 \quad (5)$$

where C is a coefficient independent of the speed and may be therefore:

$$R = C \times s^2 \quad (6)$$

From this article in the Journal of the Society of Naval Architects (1916)

If, putting this value of R in the equation (3) we obtain for the available capacity:

$$C = B - W_0 - \frac{4 \times 10^3 (1 + k_1)}{\eta} \quad (7)$$

$$R = C \times s^2$$

The amount of the air resistance value of the equation (6) may be termed the fundamental equation for dirigibles.

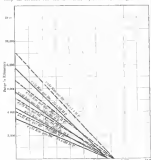


FIG. 1. INFLUENCE OF THE RESISTANCE OF THE SHIP ON CARRYING CAPACITY AS A SHIP OF THE MARINER TYPE.

POSSIBILITY OF INCREASED CARRYING CAPACITY, WITH CONSTANT COEFFICIENTS OF IMPROVING RESISTANCE COEFFICIENTS

Next must be considered the possibility of an increase in the carrying capacity of rigid airships on the assumption that no change in the volumetric contents, or gas space, is not possible. The lifting force can only be increased, with a constant volume, by making use of a lighter gas. In the most favorable case (hydrogen is taken), an increase of about 7 per cent could be obtained. Practically, an increase in the carrying capacity must be obtained at this discount. The net weight of the ship cannot be appreciably decreased. There remains only the possibility of increasing the carrying capacity of the ship without any increase in volume, by a reduction in value of the resistance coefficient. This can be brought about by a better form for the dirigible.

Fig. 1 shows what may be obtained by a reduction of about 10 per cent of the coefficient of resistance, as a ship having about the same overall dimensions as the Mariner. The available carrying capacities are taken as constant, and the length of voyage in kilometers is the corresponding ordinate. The ordinate line indicates the resistance, changing when the coefficient of resistance is reduced from 2 to 1. From the diagram we obtain the following improved capacities for a weight of 4,000 kilograms:

At 74 kilograms per hour 4,100 kilograms against 3,400 kilograms
At 25 kilograms per hour 3,900 kilograms against 3,200 kilograms
At 10 kilograms per hour 3,500 kilograms against 2,700 kilograms
At 5 kilograms per hour 3,100 kilograms against 2,300 kilograms
At 1 kilogram per hour 2,700 kilograms against 1,900 kilograms

The above diagram also shows a considerable reduction in the power requirements.

POSSIBILITY OF INCREASED RANGE, WITH CONSTANT COEFFICIENTS OF IMPROVING RESISTANCE COEFFICIENTS

The overall efficiency of the air-propeller installation, which is given by letters η and η_0 in regard to the efficiency of the propellers on each other, may still be slightly improved. Fig. 2 shows, however, for the ship used as a basis for Fig. 1, that the improvement in range when η equals 0.8 instead of 0.7, η_0 equals 0.7 instead of 0.6, amounts per horsepower, and k_1 equals 0.2 is equal to a 24 kilogram per horsepower loss. The increase in range obtained thereby, as shown by the diagram, is extraordinary. We take the value from the 10,000 kilogram carrying capacity ordinate.

At 64 kilograms per hour 5,700 kilograms against 4,000 kilograms in the Mariner type
At 25 kilograms per hour 4,500 kilograms against 3,200 kilograms in the Mariner type
At 10 kilograms per hour 3,500 kilograms against 2,300 kilograms in the Mariner type
At 5 kilograms per hour 3,100 kilograms against 1,900 kilograms in the Mariner type

These figures speak for themselves, and may soon be attained.

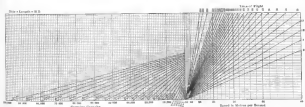


FIG. 2. INFLUENCE OF SHIP DIMENSIONS ON SPEED, CARRYING CAPACITY AND TIME OF FLIGHT.

IMPROVEMENT IN CARRYING CAPACITY AND RANGE WITH INCREASE IN SIZE

The considerations will be limited to a fleet of similar ships having the ratio of diameter to length equal to 0.1, as in-

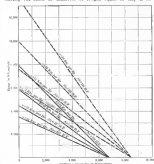


FIG. 3. INFLUENCE OF AN IMPROVEMENT OF k_1 BY 10% AND A 10% INCREASE IN THE DIAMETER OF THE MARINER TYPE.

corresponds with current practice. The outer form of the ship will also be similar to the construction in vogue at present. From experiments obtained with ships of from 11 to 160 meters in diameter, as well as the exact simple measurements obtained on ships of from 35 to 25 meters diameter, certain fundamental relations may be established which can be used for the entire range of ships of diameter from 6 to 30 meters, and a corresponding length of 60 to 300 meters. The length of the ship will always be taken as 10 times the diameter, so that when the diameter is given the other overall dimensions of the ship are definitely established.

National Advisory Committee Meeting

At the December meeting of the Executive Committee of the National Advisory Committee for Aeronautics, the committee adopted the metric system as its standard, so far as the work of the committee is concerned, and recommendations will be sent to the various departments of the Government that this system be adopted in connection with all matters pertaining to aeronautics. The War Department will put this change into effect immediately in its Aviation Section, using both the metric and English systems on all drawings for a time.

It has been found necessary to amend and add to the nomenclature for aeronautics, recently issued by the committee. The following changes were adopted at this meeting and will be incorporated into the report on nomenclature when published in the second annual report.

The question of what is a right-hand engine has occasioned a great deal of comment in the aeronautics industry, and in order to associate the words "right-hand" and "clockwise" the definition of a right-hand engine has been amended to read:

"A right-hand engine is one in which, when viewed from the output shaft, looking toward the crank shaft out its shaft to view, the motion is clockwise."

As it appeared necessary, on further consideration, to differentiate between aircraft designed for operation from land and those designed for operation from water, the committee adopted the term "amphibious" for aeroplanes in which the landing gear is suited to operation from the water. The term "amphibious" is constantly used in a more restricted sense to refer to aeroplanes fitted with landing gear suited to operation from the land.

For "Delivered as an amphibious" the committee adopted the following definition:

"The angle included at the intersection of the tangents to the surface, extending the chord of the float and hull wings (measured to the plane of symmetry, if necessary). This angle is measured in a plane perpendicular to that intersection. The chord of the upper wing rear, and frequently does differ from that of the lower wing in a biplane."

The suggestion of Naval Constructor H. C. Richards, U. S. N., as secretary of the committee, on account of his transfer to duty at the Navy's Aerographic Station, Pensacola, Fla., as construction officer, was accepted. Pending the election of a permanent successor, Dr. H. W. Strutt, Director of the Bureau of Standards, was appointed temporary secretary.

Pan-American Aeronautics Exposition

Predictably all of the leading aeronautical magazines in this country have taken space in the Pan-American Aeronautics Exposition, which will take place at the Grand Central Palace, New York, during the week of February 5 to 15, 1917. The exposition will be held under the auspices of the Aero Club of America, the Pan-American Aeronautics Federation and the Society of Aeronautics Engineers.

Howard E. Coffin, chairman of the Organizing Committee of the exposition, has extended the Army and Navy in its exhibition, and it is announced that a representative display of military and naval equipment will be made.

The exposition will come at a time when the interest in aeronautics in this country is greater than ever before and it will give the public a more complete idea of the extent of the aeronautical industry than could be had in any other way.

In the next issue of AVIATION AND AERONAUTICS, this year, there will be a complete outline of the plan in making this exposition worthy of the country.

Dimensions and Performance of Superaeroplanes

Figures on the dimensions and performance of the last superaeroplanes that are regularly exhibited are published in this issue. Four ships have been built at Fordhamville and tested over Lake Champlain of which the following data are given: Length, 210 meters; diameter, 22 meters; volume, 12,000 cubic meters; horsepower, 4,000 to 5,000 on right motor, maximum climb, 5,000 meters, speed 130 miles, maximum speed, 120 kilometers per hour. The design can carry a maximum load of 1,000 kilograms.

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Captain Rold Amundsen, the Norwegian explorer, who has successfully reached the South Pole, announced again his arrival in the United States that he was preparing a workable expedition and was contemplating the use of an airplane to accomplish his other exploring work.

Henry H. Hensley, president of the Standard Aero Corporation, offered to present Captain Amundsen with a specially designed machine. Captain Amundsen has been a pilot for some years.

The airplane will be used to make wide range explorations and to pick out suitable places for carrying on the work of gathering data on windings and currents which is the scientific justification of polar exploration.



It is estimated that the new French double-bayonet aerial gun which weighs 25 lb. and can fire 100 rounds a minute is a wide angle of operation.

Book Review

SMALL FACTORY OUTPUT AND HOW TO SPEED IT UP

By George H. Mansfield

This book does not deal specifically with airports to construction, but the methods which it describes are readily applicable to airplane work. It has, in fact, been written in view of the hurried work which airplane factories in Great Britain are having to face during the present war. The book deals with such matters as arrangement of factory departments, selection of men and change-bands, tools, stores and instruments, work taking and progress records, new material, new and old arrangements. Several useful charts, such as factory diagrams, job card, progress sheets are included.

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Causes and Remedies of Airplane Accidents

Leontine H. C. Smith, U. S. N., in the U. S. Nat. Acad. of Sciences, Philadelphia, gives the causes of accidents under three heads: air controller defects in materials, and personal error. With experiments in materials and an increase in the number of pilots, it is the personal error that is now responsible for a major part of the accidents.

Defects in construction and material can be largely eliminated by a thorough inspection at the factory and on the field. Particular attention is called to weak-point exposures and to poorly made push-rod and bridle of which many failures, causing serious damage, have been caused. Many accidents are caused by having given trouble in aerial practice by jumping the airplane as a member of formation.

The present type of extended wing is considered as unsuitable and dangerous, and the substitution of heavy wire with bell-crank or of a rod and lever system is advocated for changing the direction of pull.

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Propellers or airplanes are reported to have been particularly troublesome, as the shedding is liable to become loosed by corrosion and by the impact of spray, to be exposed as frequently while in flight. The in-durability in position, when the firing metal only completely, were one of the bad things.

A Suggested Type of Aircraft

In a paper read before the Institution of Civil Engineers of France, A. Brachet presented experiments on a model in a new type of aircraft that are machines. As shown in the appended sketch, the model embodies certain features of the machine I propose, but its propeller and exhaustive system are made of a number of disks shaped like the blades of a fan. These disks are driven by a motor which transmits rapidly to specific directions on two vertical shafts.

The experiments have been conducted with an electric motor which gave a speed of from 1,600 to 1,500 revolutions per minute to the disks. When the required speed of revolution was attained the model was set free. It maintained a steady, but wavy and somewhat wobbly, and proved its position and stability. The model is said to correspond to a full size machine of 30 meters high and a weight of 475 kilograms.

According to M. Brachet such a machine would possess the stability under all circumstances, chiefly because of its upper action. The author advocates strongly that similar ideas be given to other types besides that of the triangular airplane of the present day.

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